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TITLE: ELECTRODE STRUCTURE FOR PIEZOELECTRIC ELEMENT AND ITS MANUFACTURE

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ABSTRACT:

PROBLEM TO BE SOLVED: To provide an electrode structure for piezoelectric element which is capable of preventing the breakage of a piezoelectric element by sufficiently relieving large residual stresses which are applied to the element at all times, in a high-temperature environment by forming stress relaxable layers which is capable of relieving the large residual stresses in conductive electrodes.

SOLUTION: For an electrode structure for piezoelectric element, in which conductive electrodes 7 are respectively arranged between and jointed to the jointing surfaces of first and second **piezoelectric elements 2 laminated** into at least two layers, each conductive electrode 7 is composed of conducting layers 3 which are respectively jointed to and arranged on the first and second piezoelectric elements 2, **stress** relieving layers 4 which are respectively jointed to and arranged on the conductive layers 3 and formed by mixing a conductive material in an inorganic porous material, and an interlayer jointing layer 9, which integrally joints the **stress**-relieving layer 4 on the first piezoelectric element 2 side to the **stress**-relieving layer 4 on the second piezoelectric element 2 side.

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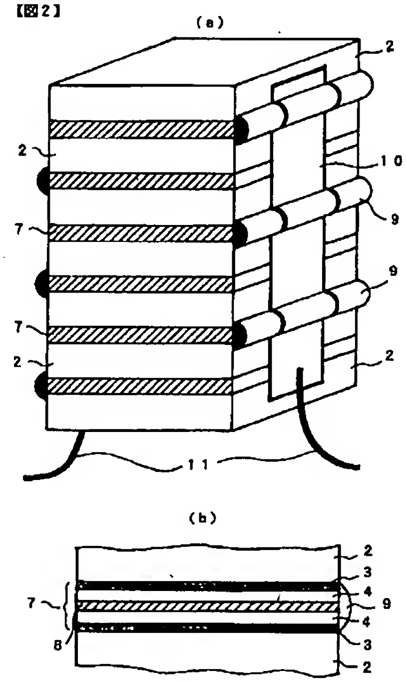
(54)【発明の名称】　圧電素子電極構造及びその製造方法

(57)【要約】　（修正有）

【課題】　大きな残留応力を緩和可能にした応力緩和層を導電性電極内に形成し、高温状態の環境下において圧電素子に常時加わる大きな残留応力を十分に緩和し、圧電素子の破損を防いだ圧電素子電極構造を提供する。

【解決手段】　少なくとも２層に積層された第１及び第２圧電素子２の接合面に導電性電極７を接合配置した圧電素子電極構造において、導電性電極７は、第１及び第２圧電素子２上にそれぞれ接合配置される導電層３と、各導電層３上にそれぞれ接合配置され、無機質多孔体に導電性物質を混在した構造の応力緩和層４と、第１圧電素子２側の応力緩和層４と第２圧電素子２側の応力緩和層４とを一体接合する層間接合層９とからなっている

【図２】



【特許請求の範囲】

【請求項１】　圧電素子の両面に導電性電極を接合配置した圧電素子電極構造において、前記導電性電極は、前記圧電素子上に接合される導電層と、前記導電層上に接合され、無機質多孔体に導電性物質を混在した構造の応力緩和層とからなっていることを特徴とする圧電素子電極構造。

【請求項２】　少なくとも２層に積層された第１及び第２圧電素子の接合面に導電性電極を接合配置した圧電素子電極構造において、前記導電性電極は、前記第１及び第２圧電素子上にそれぞれ接合配置される導電層と、前記各導電層上にそれぞれ接合配置され、無機質多孔体に導電性物質を混在した構造の応力緩和層と、前記第１圧電素子側の応力緩和層と前記第２圧電素子側の応力緩和層とを一体接合する層間接合層とからなっていることを特徴とする圧電素子電極構造。

【請求項３】　前記無機質多孔体に混在した導電性物質は、導電性粒子を含んだものであることを特徴とする請求項１または２に記載の圧電素子電極構造。

【請求項４】　前記導電性粒子は、平均粒径が５μｍ以下の微粒子からなるものであることを特徴とする請求項３に記載の圧電素子電極構造。

【請求項５】　圧電素子を構成する圧電板の少なくとも一面に、導電性粒子を含有するゾル溶液を塗布して導電塗布膜を形成する工程と、

前記導電塗布膜上に導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液を塗布して第２塗布膜を形成し、その第２塗布膜を前記導電塗布膜とともに加熱乾燥し、導電層及び応力緩和層を形成する工程と、を経て導電性電極を製造することを特徴とする圧電素子電極構造の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、圧電素子電極構造及びその製造方法に係わり、特に、圧電素子が高温状態の環境下で動作する際に、圧電素子に加わる比較的大きな応力を緩和するため、圧電素子の導電性電極の一部に応力緩和層を形成配置した圧電素子電極構造及びその製造方法に関する。

【０００２】

【従来の技術】一般に、圧電素子は、電気的エネルギーと機械的エネルギーとを相互変換する素子であって、これらのエネルギーを相互変換する場合、圧電素子の両面に導電性電極を接合配置し、これら導電性電極間に交流電圧（信号）を加えることにより、圧電素子からその交流電圧（信号）に対応した機械的振動を発生させたり、圧電素子に機械的振動を加えることにより、導電性電極間からその機械的振動に対応した交流電圧（信号）を出力させたりしている。

【０００３】ところで、このような圧電素子は、例えば、アクチュエーターやセンサー等に使用される場合、その相互変換効率を高めるため、圧電素子と導電性電極とを交互に積層し、積層形圧電素子として用いることが知られている。この積層形圧電素子は、常温状態の環境下において使用されている限り、それ程大きな問題にはならないが、高温状態の環境下において使用されるようになると、圧電素子と導電性電極との熱膨張係数の差に基づいて、即ち、圧電素子の熱膨張係数に比べて導電性電極の熱膨張係数が比較的大きいため、熱膨張した導電性電極が大きな残留応力として常時圧電素子に加わるようになり、使用中に圧電素子がこの大きな残留応力に耐え切れず、圧電素子が破損してしまうという問題がある。

【０００４】このような問題に対して、圧電素子に加わる大きな残留応力を緩和させて、使用中の圧電素子の破損等を防ぐことを可能にした圧電素子電極構造が、特開平８－１９５５１２号によって既に提案されている。

【０００５】この特開平８－１９５５１２号で提案された圧電素子電極構造は、圧電素子の両面に接合される導電性電極を、圧電素子上に接合される平均粒径が０．１μｍ以下の導電性微粒子からなる電極層と、この電極層上に接合される比較的粗い粒子からなる緩衝層の２重層構造にし、導電性電極の熱膨張によって圧電素子に加わる大きな残留応力をこの緩衝層によって緩和させ、圧電素子の破損を防ぐようにしたものである。

【０００６】

【発明が解決しようとする課題】前記特開平８－１９５５１２号に提案された圧電素子電極構造は、導電性電極に緩衝層を設けたことにより、一応のところ、圧電素子に加わる大きな残留応力を緩和することが可能になる。

【０００７】しかるに、前記特開平８－１９５５１２号に提案された圧電素子電極構造は、圧電素子を高温状態の環境下において長期間にわたって使用した場合、圧電素子と導電性電極との熱膨張係数の差がかなり大きいために、このような緩衝層を設けただけでは十分に圧電素子に加わる残留応力を緩和することができず、圧電素子に絶えず加わる比較的大きな残留応力によって圧電素子が疲労し、遂に圧電素子が破損してしまう場合があるという問題を有するものである。

【０００８】本発明は、このような問題点を解決するもので、その目的は、大きな残留応力を緩和することを可能にした応力緩和層を導電性電極内に形成し、高温状態の環境下において圧電素子に常時加わる大きな残留応力を十分に緩和し、圧電素子の破損を防いだ圧電素子電極構造を提供することにある。

【０００９】

【課題を解決するための手段】前記目的を達成するために、本発明による圧電素子電極構造は、圧電素子の両面に接合配置される導電性電極を、圧電素子上に接合される導電層と、導電層上に接合され、無機質多孔体に導電

性物質を混在した構造の応力緩和層とで構成した第１の手段を具備する。

【００１０】前記目的を達成するために、本発明による圧電素子電極構造は、積層された２つ以上の圧電素子の接合面に接合配置される導電性電極を、圧電素子上に接合される導電層と、導電層上に接合され、無機質多孔体に導電性物質が混在した応力緩和層と、一方の圧電素子の応力緩和層と他方の圧電素子の応力緩和層とを一体接合する層間接合層とで構成した第２の手段を具備する。

【００１１】前記第１の手段によれば、圧電素子上に導電層を接合するとともに、その導電層上に応力緩和層を接合し、応力緩和層を無機質多孔体に導電性物質を混在した構成にしているので、圧電素子と導電性電極との熱膨張係数の違いに基づいて発生する大きな残留応力が、応力緩和層の無機質多孔体自体の変形及び／または無機質多孔体に混在する導電性物質の滑り動作等によって十分に緩和されるようになる。

【００１２】前記第２の手段によれば、積層される圧電素子の接合面側に導電層を介してそれぞれ応力緩和層を接合し、これらの応力緩和層を一体接合するとともに、応力緩和層を無機質多孔体に導電性物質を混在した構成にしているので、圧電素子と導電性電極との熱膨張係数の違いに基づいて発生する大きな残留応力が、応力緩和層の無機質多孔体自体の変形及び／または無機質多孔体に混在する導電性物質の滑り動作等によって十分に緩和されるようになる。

【００１３】

【発明の実施の形態】本発明の実施の形態の１つのものにおいて、圧電素子電極構造は、圧電素子の両面に導電性電極を接合配置したものであって、導電性電極は、圧電素子上に接合される導電層と、導電層上に接合され、無機質多孔体に導電性物質を混在した構造の応力緩和層とからなっているものである。

【００１４】本発明の実施の形態の他のものにおいて、圧電素子電極構造は、少なくとも２層に積層された第１及び第２圧電素子の接合面に導電性電極を接合配置したものであって、導電性電極は、第１及び第２圧電素子上にそれぞれ接合配置される導電層と、各導電層上にそれぞれ接合配置され、無機質多孔体に導電性物質を混在した構造の応力緩和層と、第１圧電素子側の応力緩和層と第２圧電素子側の応力緩和層とを一体接合する層間接合層とからなっているものである。

【００１５】本発明の実施の形態の１つまたは他のものの具体例において、圧電素子電極構造は、応力緩和層が、無機質多孔体に混在した導電性物質内に導電性粒子を含んでいるものからなり、好ましくは、その導電性粒子として、平均粒径が５μｍ以下の微粒子からなるものである。

【００１６】本発明による圧電素子電極構造の実施の形態のこれらのものによれば、圧電素子上に直接導電層を接合し、これらの導電層上にそれぞれ応力緩和層を接合するとともに、各応力緩和層を無機質多孔体に導電性物質を混在した構成にしているので、圧電素子と導電性電極との熱膨張係数の違いに基づいて、圧電素子と導電性電極との間に大きな残留応力が発生しても、その大きな残留応力は、応力緩和層の無機質多孔体自体が変形したり、または、無機質多孔体に混在する導電性物質が滑り動作を行ったり、あるいは、無機質多孔体自体の変形と導電性物質の滑り動作とが併用されることにより、十分に緩和されるようになり、その結果、圧電素子の破損を防ぐことが可能な圧電素子電極構造を得ることができる。

【００１７】この場合、無機質多孔体に混在させる導電性物質を導電性粒子で構成すれば、大きな残留応力に対する緩和機能が増大し、また、導電性粒子に平均粒径が５μｍ以下のものを使用すれば、大きな残留応力に対する緩和機能をより増大させることが可能になる。

【００１８】また、本発明の別の実施の形態において、圧電素子電極構造の製造方法は、圧電素子を構成する圧電板の少なくとも一面に、導電性粒子を含有するゾル溶液を塗布して導電塗布層を形成する工程と、導電塗布層上に導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液を塗布して第２塗布膜を形成し、その第２塗布膜を導電塗布層とともに加熱乾燥し、応力緩和層及び導電層を形成する工程とを経て導電性電極を製造するものである。

【００１９】本発明による圧電素子電極構造の製造方法の実施の形態によれば、圧電板の表面に、導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液を塗布し、これらのゾル溶液を塗布した領域を加熱乾燥させることによって、応力緩和層が形成されるので、比較的簡単な製造手段を用いることができるだけでなく、安価な製造コストにより、圧電素子に加わる大きな残留応力を緩和可能な圧電素子電極構造を製造することができる。

【００２０】

【実施例】以下、本発明の実施例を図面を参照して説明する。

【００２１】図1は、本発明に係わる圧電素子電極構造の第１実施例の構成を示す断面図である。

【００２２】図1において、1は導電性電極、2は圧電セラミック素子（圧電素子）、3は導電層、4は応力緩和層、4_1 は無機質多孔体、4_2 は導電性微粒子、5は接着層、6は素子保持部である。

【００２３】そして、導電性電極1は、圧電セラミック素子2の両面上にそれぞれ接着配置された導電層３と、それぞれの導電層３上に接着配置された応力緩和層４とからなるもので、応力緩和層４は、無機質多孔体4_1 と導電性微粒子4_2 とからなっている。この応力緩和層４において、導電性微粒子4_2 は、無機質多孔体4_1 の各

多孔部内に充填配置されるとともに、各多孔部周辺に分散配置された状態になっている。それぞれの応力緩和層4は、接着層5を介して素子保持部6に接着され、それによって、両面に導電性電極1を接着配置した圧電セラミック素子2は素子保持部6により保持される。

【0024】この場合、応力緩和層4は、使用する無機質多孔体4_1や導電性微粒子4_2の物理的特性によって若干異なるが、概ね、その厚さが100μm以下になるように形成することが好ましい。この理由は、応力緩和層4の厚さが100μmを超えるような場合、圧電セラミック素子2と応力緩和層4との熱膨張係数の違いに基づく残留応力が大きくなり、圧電セラミック素子2と応力緩和層4とが剥離することがあるからである。

【0025】また、応力緩和層4に使用される導電性微粒子4_2は、平均粒径が5μm以下の微粒子を用いると好適である。即ち、導電性微粒子4_2として、平均粒径が5μm以下の微粒子、例えば、平均粒径が1μm程度の微粒子を用いた場合には、無機質多孔体4_1の多孔部内に充填された状態にある微粒子や多孔部を包囲した状態にある微粒子が、応力緩和層4内で良好な潤滑作用を呈し、圧電セラミック素子2に加わる残留応力を有効的に低減する。一方、導電性微粒子4_2として、平均粒径が5μm以上の微粒子を用いた場合には、応力緩和層4内におけるそれらの粒子の潤滑作用がそれ程良好ではなくなり、圧電セラミック素子2に加わる残留応力の低減が有効的に行われなくなって、圧電セラミック素子2に加わる大きな残留応力により、遂に圧電セラミック素子2が破損することがある。

【0026】このように、第1実施例の圧電素子電極構造によれば、圧電セラミック素子2上に導電層3を接合するとともに、その導電層3上に応力緩和層4を接合し、この応力緩和層4を無機質多孔体4_1に導電性微粒子4_2を混在した構成にしているので、圧電セラミック素子2と導電性電極1との熱膨張係数の違いに基づいて発生する大きな残留応力が、応力緩和層4の無機質多孔体4_1自体の変形及び／または無機質多孔体4_1に混在する導電性微粒子4_2の滑り動作等によって十分に緩和され、例えば、高温度状態の環境下で圧電セラミック素子2を使用したとしても、圧電セラミック素子2が破損するのを未然に防止することができる。

【0027】次に、図2（a）、（b）は、本発明に係わる圧電素子電極構造の第2実施例の構成を示す構成図であって、（a）はその斜視図、（b）はその一部の拡大断面構成図であり、圧電素子を積層型圧電素子に構成した例を示すものである。

【0028】図2（a）、（b）において、7は導電性電極、8は層間接着層、9は絶縁体、10は帯状外部電極、11はリードであり、その他、図1に示された構成要素と同じ構成要素については同じ符号を付けている。

【0029】そして、導電性電極7は、積層された2つ

の圧電セラミック素子2間に形成配置されるもので、一方（上側）の圧電セラミック素子2と他方（下側）の圧電セラミック素子2の各対向面上にそれぞれ接着配置された導電層3と、各導電層3上にそれぞれ接着配置された応力緩和層4と、各応力緩和層4を接着する層間接着層9からなる。各応力緩和層4は、無機質多孔体4_1と導電性微粒子4_2とからなり、導電性微粒子4_2は、無機質多孔体4_1の各多孔部内に充填配置されるとともに、各多孔部周辺に分散配置された状態になっている。

【0030】また、それぞれの導電性電極7は、奇数番目の導電性電極7における一方の側面が露出した状態に、他方の側面が絶縁体9を装着した状態にそれぞれ形成され、反対に、偶数番目の導電性電極7における一方の側面が絶縁体9を装着した状態に、他方の側面が露出した状態にそれぞれ形成されている。それぞれの導電性電極7の一方の側面及び他方の側面には、それぞれ、圧電セラミック素子1の積層方向に沿って帯状外部電極10が装着配置され、それぞれの導電性電極7は、その露出した部分において各帯状外部電極10に導電接続され、絶縁体9を装着した部分において各帯状外部電極10と絶縁されている。なお、それぞれの帯状外部電極10の端部にリード11が接続されている。

【0031】第2実施例においても、第1実施例と同様に、応力緩和層4は、使用する無機質多孔体4_1や導電性微粒子4_2の物理的特性によって若干異なるが、概略、その厚さが100μm以下になるように形成することが好ましい。その理由は、応力緩和層4の厚さが100μmを超えるような場合、圧電セラミック素子2と応力緩和層4との熱膨張係数の違いに基づく残留応力が大きくなり、圧電セラミック素子2と応力緩和層4とが剥離することがあるからである。

【0032】また、第2実施例においても、第1実施例と同様に、応力緩和層4に使用される導電性微粒子4_2は、平均粒径が5μm以下の微粒子を用いると好適である。即ち、導電性微粒子4_2として、平均粒径が5μm以下の微粒子、例えば、平均粒径が1μm程度の微粒子を用いた場合には、無機質多孔体4_1の多孔部内に充填された状態にある微粒子4_2や多孔部を包囲した状態にある微粒子4_2が、応力緩和層4内で良好な潤滑作用を呈し、圧電セラミック素子2に加わる残留応力を有効的に低減する。一方、導電性微粒子4_2として、平均粒径が5μm以上の微粒子を用いた場合には、応力緩和層4内におけるそれらの微粒子の潤滑作用がそれ程良好ではなくなり、圧電セラミック素子2に加わる残留応力の低減が有効的に行われなくなって、圧電セラミック素子2に加わる大きな残留応力により、遂に圧電セラミック素子2が破損することがある。

【0033】このように、第2実施例の圧電素子電極構造によれば、積層される圧電セラミック素子2の接合面側に導電層3を介してそれぞれ応力緩和層4を接合し、

これらの応力緩和層４を一体接合するとともに、応力緩和層４を無機質多孔体4_1に導電性微粒子4_2を混在した構成にしているので、圧電セラミック素子２と導電性電極７との熱膨張係数の違いに基づいて発生する大きな残留応力が、応力緩和層４の無機質多孔体4_1自体の変形及び／または無機質多孔体4_1に混在する導電性微粒子4_2の滑り動作等によって十分に緩和されるようになり、例えば、高温度状態の環境下でこの積層型圧電セラミック素子２を使用したとしても、各圧電セラミック素子２が破損するのを未然に防止することができる。

【００３４】ここで、第１実施例及び第２実施例の圧電素子電極構造の製造方法について述べると、次のとおりである。

【００３５】始めに、第１実施例１の圧電素子電極構造は、次のようにして製造される。

【００３６】まず、チタン酸ジルコン酸塩（ＰＺＴ）を主成分とする所定寸法、例えば、縦５ｍｍ、横５ｍｍ、厚さ０．５ｍｍの圧電セラミック板１を用意する。

【００３７】次に、この圧電セラミック板１の両面に銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子を２０％含有したゾル溶液を塗布する。

【００３８】次いで、前記ゾル溶液を塗布した領域上に、酸化ケイ素（SiO_2）を２０％含有したゾル溶液と銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子を２０％含有したゾル溶液とを交互に塗布する。

【００３９】続いて、圧電セラミック板１に塗布した各ゾル溶液を、温度２００℃で３０分間加熱し、導電層３及び応力緩和層４からなる導電性電極１を形成する。

【００４０】次いで、両面に導電性電極１を形成した圧電セラミック板１を、ニッケル（Ｎｉ）とジルコニアを主成分とする無機高温接着材を用いて素子保持部６に接着させ、導電性電極１を形成した圧電セラミック素子１を、接着層５によって素子保持部６に保持させる。

【００４１】このようにして製造された圧電素子電極構造は、圧電板の表面に、導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液を塗布し、これらのゾル溶液を塗布した領域を加熱乾燥させることによって、応力緩和層を形成することができるので、比較的簡単な製造手段を用いることができるとともに、安価な製造コストによって、圧電素子に加わる大きな残留応力を緩和可能な圧電素子電極構造を製造することができる。

【００４２】次に、第２実施例の圧電素子電極構造は、次のようにして製造される。

【００４３】まず、チタン酸ジルコン酸塩（ＰＺＴ）を主成分とする所定寸法、例えば、縦５ｍｍ、横５ｍｍ、厚さ０．５ｍｍの圧電セラミック板１を、積層される数だけ用意する。

【００４４】次に、これらの圧電セラミック板１の中の２つの圧電セラミック板１の一面、残りの圧電セラミック板１の両面に、それぞれ、銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子を２０％含有したゾル溶液を塗布する。

【００４５】次いで、前記ゾル溶液を塗布した各領域上に、酸化ケイ素（SiO_2）を２０％含有したゾル溶液と銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子を２０％含有したゾル溶液とを交互に塗布する。

【００４６】続いて、それぞれの圧電セラミック板１に塗布した各ゾル溶液を、温度２００℃で３０分間加熱し、導電層３及び応力緩和層４を形成する。

【００４７】次に、各圧電セラミック板１に形成した応力緩和層４の積層するもの同志をそれぞれ対向させ、ニッケル（Ｎｉ）とジルコニアを主成分とする無機高温接着材を用い、それぞれ対向させた２つの応力緩和層４を接着させ、導電性電極７を形成する。このとき、積層配置される各圧電セラミック板１の間にそれぞれ導電性電極７が装着配置された積層型圧電素子を得ている。

【００４８】次いで、積層型圧電素子の導電性電極７の一方及び他方の側面に、それぞれ、１つ置きに断面かまぼこ形の絶縁体９を装着する。

【００４９】続いて、積層型圧電素子の導電性電極７の一方及び他方の側面に、それぞれ帯状外部電極１０を接合装着し、各帯状外部電極１０の端部にリード１１を溶接接合する。

【００５０】このようにして製造された圧電素子電極構造は、第１実施例の圧電素子電極構造の製造方法と同様に、２つ以上の圧電板の表面に、導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液をそれぞれ塗布し、これらゾル溶液を塗布した領域をそれぞれ加熱乾燥させることによって、応力緩和層を形成することができるので、比較的簡単な製造手段を用いることができるとともに、安価な製造コストによって、圧電素子に加わる大きな残留応力を緩和可能な圧電素子電極構造を製造することができる。

【００５１】なお、第１及び第２実施例の圧電素子電極構造の製造方法においては、導電性粒子として、銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子を用いた例を挙げて説明したが、本発明の製造方法に使用可能な導電性粒子は銀（Ａｇ）粒子とパラジウム（Ｐａ）粒子に限られるものでなく、良好な導電性を有する金属粒子であれば他の粒子を用いるようにしてもよい。

【００５２】また、第１及び第２実施例の圧電素子電極構造の製造方法においては、接着層を形成する際に、ニッケル（Ｎｉ）とジルコニアを主成分とする無機高温接着材を用いた例を挙げて説明したが、本発明の製造方法に使用可能な接着剤はニッケル（Ｎｉ）とジルコニアを主成分とする無機高温接着材に限られるものでなく、この無機高温接着材に類似の性質を持つ接着剤であれば他の接着剤用いるようにしてもよい。

【００５３】ちなみに、第２実施例の圧電素子電極構造を有する積層型圧電素子を、ガソリンエンジンの燃料供給装置に組込み、ガソリン噴射用アクチュエーターに用

いて試験を行った。この試験は、温度１２０℃の環境下で、エンジン回転数を５００乃至１００００ｒｐｍに変化させ、ガソリンの噴射状態を調べるもので、その結果は、従来の電磁式アクチュエーターを用いた場合に比べて、全てのエンジン回転数において、入力信号に対するガソリン噴射応答速度を１／５以下に低減することができた。

【００５４】

【発明の効果】以上のように、本発明の圧電素子電極構造によれば、圧電素子上に直接導電層を接合し、この導電層上にそれぞれ応力緩和層を接合するとともに、各応力緩和層を無機質多孔体に導電性物質を混在した構成にしているので、圧電素子と導電性電極との熱膨張係数の違いに基づいて、圧電素子と導電性電極との間に大きな残留応力が発生しても、その大きな残留応力は、応力緩和層の無機質多孔体自体が変形したり、または、無機質多孔体に混在する導電性物質が滑り動作を行ったり、あるいは、無機質多孔体自体の変形と導電性物質の滑り動作とが併用されることによって十分に緩和され、その結果、圧電素子の破損を防ぐことが可能な圧電素子電極構造が得られるという効果がある。

【００５５】この場合、無機質多孔体に混在させる導電性物質を導電性粒子で構成することにより、大きな残留応力に対する緩和機能が増大するという効果があり、また、導電性粒子として、平均粒径が５μｍ以下のものを使用すれば、大きな残留応力に対する緩和機能をより増大させることが可能になるという効果がある。

【００５６】また、本発明の圧電素子電極構造の製造方法によれば、圧電板の表面に、導電性粒子を含有するゾル溶液及び酸化ケイ素を含有するゾル溶液を塗布し、これらのゾル溶液の塗布領域を加熱乾燥させて応力緩和層を形成しているので、比較的簡単な製造手段を用いることができる他に、安価な製造コストで、圧電素子に加わる大きな残留応力を緩和可能な圧電素子電極構造を製造できるという効果がある。

【図面の簡単な説明】

【図１】本発明に係わる圧電素子電極構造の第１実施例の構成を示す断面図である。

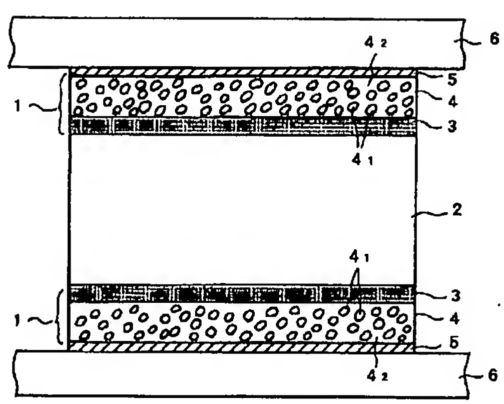
【図２】本発明に係わる圧電素子電極構造の第２実施例の構成を示す斜視図及び一部の拡大断面図である。

【符号の説明】

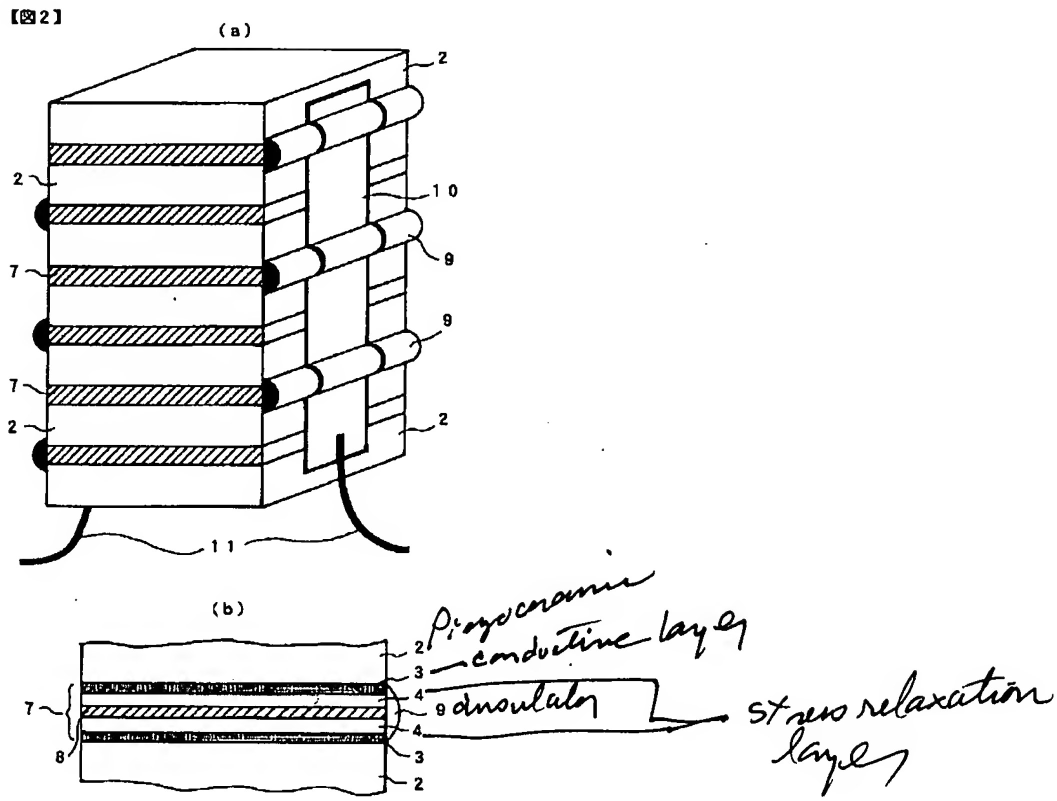
１、７　導電性電極
２　圧電セラミック素子（圧電素子）
３　導電層
４　応力緩和層
4_1　無機質多孔体
4_2　導電性微粒子
５　接着層
６　素子保持部
８　層間接着層
９　絶縁体
１０　帯状外部電極
１１　リード

【図１】

【図１】



【図２】



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the piezoelectric-device electrode structure which carried out formation arrangement of the stress relaxation layer, and its manufacture approach at some conductive electrodes of a piezoelectric device in order to ease the comparatively big stress which joins a piezoelectric device, in case a piezoelectric device operates under the environment of an elevated-temperature condition with respect to piezoelectric-device electrode structure and its manufacture approach.
[0002]
[Description of the Prior Art] Generally a piezoelectric device is a component which carries out the interconversion of electric energy and the mechanical energy. By carrying out junction arrangement of the conductive electrode, and applying alternating voltage (signal) to both sides of a piezoelectric device these conductivity inter-electrode, when carrying out the interconversion of such energy Alternating voltage (signal) corresponding to the mechanical oscillation is made to output from conductive inter-electrode one by generating the mechanical oscillation corresponding to the alternating voltage (signal) from a piezoelectric device, or adding mechanical oscillation to a piezoelectric device.
[0003] By the way, when used for an actuator, a sensor, etc., in order that such a piezoelectric device may raise the interconversion effectiveness, carrying out the laminating of a piezoelectric device and the conductive electrode by turns, and using them as a laminating form piezoelectric device is known. This laminating form piezoelectric device does not become so big a problem, as long as it is used for the bottom of the environment of an ordinary temperature condition, but if used [come] for the bottom of the environment of an elevated-temperature condition It compares with the coefficient of thermal expansion of a piezoelectric device based on the difference of the coefficient of thermal expansion of a piezoelectric device and a conductive electrode. Since the coefficient of thermal expansion of a conductive electrode is comparatively large, During an activity, the conductive electrode which expanded thermally always comes to join a piezoelectric device as big residual stress, and it does not go out [a piezoelectric device bears, and] to this big residual stress, but there is a problem that a piezoelectric device will be damaged.
[0004] The big residual stress which joins a piezoelectric device is made to ease to such a problem, and the piezoelectric-device electrode structure which made it possible to prevent breakage of a piezoelectric device in use etc. is already proposed by JP,8-195512,A.
[0005] The piezoelectric-device electrode structure proposed by this JP,8-195512,A makes the conductive electrode joined by both sides of a piezoelectric device the double layer system of the electrode layer which the mean particle diameter joined on a piezoelectric device becomes from a conductive particle 0.1 micrometers or less, and the buffer coat which consists of a comparatively coarse particle joined on this electrode layer, makes the big residual stress which joins a piezoelectric device by the thermal expansion of a conductive electrode ease by this buffer coat, and prevents breakage of a piezoelectric device.

[0006]
[Problem(s) to be Solved by the Invention] It enables the piezoelectric-device electrode structure proposed by said JP,8-195512,A to ease the big residual stress which joins a piezoelectric device a temporary place by having prepared the buffer coat in the conductive electrode.
[0007] However, the piezoelectric-device electrode structure proposed by said JP,8-195512,A When a piezoelectric device is used over a long period of time for the bottom of the environment of an elevated-temperature condition, since the difference of the coefficient of thermal expansion of a piezoelectric device and a conductive electrode is quite large The residual stress which fully joins a piezoelectric device cannot be eased only by preparing such a buffer coat; but a piezoelectric device gets fatigued with the comparatively big residual stress which joins a piezoelectric device continuously, and it has the problem that a piezoelectric device may be damaged at last.
[0008] This invention solves such a trouble, and the object forms the stress relaxation layer which made it possible to ease big residual stress in a conductive electrode, fully eases the big residual stress which always joins a piezoelectric device under the environment of an elevated-temperature condition, and is to offer the piezoelectric-device electrode structure which prevented breakage of a piezoelectric device.
[0009]
[Means for Solving the Problem] In order to attain said object, the piezoelectric-device electrode structure by this invention possesses the 1st means constituted from a conductive layer joined on a piezoelectric device in the conductive electrode by which junction arrangement is carried out to both sides of a piezoelectric device, and a stress relaxation layer of the structure which was joined at the conductive layer top and intermingled in the conductive matter in the minerals porous body.
[0010] In order to attain said object, the piezoelectric-device electrode structure by this invention The conductive layer joined by the plane of composition of two or more piezoelectric devices by which the laminating was carried out on a piezoelectric device in the conductive electrode by which junction arrangement is carried out, The 2nd means constituted from a junctional zone between layers which is joined on a conductive layer and really joins the stress relaxation layer in which the conductive matter was intermingled, and the stress relaxation layer of one piezoelectric device and the stress relaxation layer of the piezoelectric device of another side to a minerals porous body is provided.
[0011] Since according to said 1st means a stress relaxation layer is joined on the conductive layer and the stress relaxation layer is made the configuration intermingled in the conductive matter in the minerals porous body while joining a conductive layer on a piezoelectric device, the big residual stress generated based on the difference in the coefficient of thermal expansion of a piezoelectric device and a conductive electrode fully comes to be eased by slipping actuation of the conductive matter intermingled in deformation of the minerals porous body of a stress relaxation layer itself, and/or a minerals porous body etc.
[0012] While according to said 2nd means joining a stress relaxation layer to the plane-of-composition side of the piezoelectric device by which a laminating is carried out through a conductive layer, respectively and really joining these stress relaxation layers Since the stress relaxation layer is made the configuration intermingled in the conductive matter at the minerals porous body The big residual stress generated based on the difference in the coefficient of thermal expansion of a piezoelectric device and a conductive electrode fully comes to be eased by slipping actuation of the conductive matter intermingled in deformation of the minerals porous body of a stress relaxation layer itself, and/or a minerals porous body etc.
[0013]
[Embodiment of the Invention] In one thing of the gestalt of operation of this invention, piezoelectric-device electrode structure carries out junction arrangement of the conductive electrode to both sides of a piezoelectric device, and the conductive electrode consists of a conductive layer joined on a piezoelectric device, and a stress relaxation layer of the structure which was joined on the conductive layer and intermingled in the conductive matter in the minerals porous body.
[0014] In other things of the gestalt of operation of this invention piezoelectric-device electrode structure Junction arrangement of the conductive electrode is carried out in the plane of composition of

the 1st and 2nd piezoelectric devices by which the laminating was carried out at least to two-layer. A conductive electrode The conductive layer by which junction arrangement is carried out on the 1st and 2nd piezoelectric devices, respectively, and the stress relaxation layer of the structure which junction arrangement was carried out on each conductive layer, respectively, and was intermingled in the conductive matter in the minerals porous body, It consists of a junctional zone between layers which really joins the stress relaxation layer by the side of the 1st piezoelectric device, and the stress relaxation layer by the side of the 2nd piezoelectric device.

[0015] In the example of the one or other things of the gestalt of operation of this invention, piezoelectric-device electrode structure consists of a thing containing a conductive particle in the conductive matter with which the stress relaxation layer was intermingled in the minerals porous body, and mean particle diameter consists of a particle 5 micrometers or less as the conductive particle preferably.

[0016] While according to these things of the gestalt of operation of the piezoelectric-device electrode structure by this invention joining a direct conductive layer on a piezoelectric device and joining a stress relaxation layer on these conductive layers, respectively Since each stress relaxation layer is made the configuration intermingled in the conductive matter at the minerals porous body Even if big residual stress occurs between a piezoelectric device and a conductive electrode based on the difference in the coefficient of thermal expansion of a piezoelectric device and a conductive electrode, the big residual stress The minerals porous body of a stress relaxation layer itself deforms, or or the conductive matter intermingled in a minerals porous body performs slipping actuation, or Or the piezoelectric-device electrode structure which it fully comes to be eased, consequently can prevent breakage of a piezoelectric device can be acquired by using together deformation of the minerals porous body itself and slipping actuation of the conductive matter.

[0017] In this case, if the relaxation function to big residual stress will increase if the conductive matter which makes a minerals porous body intermingled is constituted from a conductive particle, and mean particle diameter uses a thing 5 micrometers or less for a conductive particle, it will become possible to increase the relaxation function to big residual stress more.

[0018] In the gestalt of another operation of this invention moreover, the manufacture approach of piezoelectric-device electrode structure The process which applies the sol solution of the piezo-electric plate which constitutes a piezoelectric device which contains a conductive particle on the whole surface at least, and forms an electric conduction spreading layer, On an electric conduction spreading layer, the sol solution containing the sol solution and silicon oxide containing a conductive particle is applied, the 2nd spreading film is formed, stoving of the 2nd spreading film is carried out with an electric conduction spreading layer, and a conductive electrode is manufactured through the process which forms a stress relaxation layer and a conductive layer.

[0019] According to the gestalt of implementation of the manufacture approach of the piezoelectric-device electrode structure by this invention, on the front face of a piezo-electric plate Since a stress relaxation layer is formed by carrying out stoving of the field which applied the sol solution containing the sol solution and silicon oxide containing a conductive particle, and applied these sol solutions The piezoelectric-device electrode structure which it not only can use a comparatively easy manufacture means, but can ease the big residual stress which joins a piezoelectric device with a cheap manufacturing cost can be manufactured.

[0020]

[Example] Hereafter, the example of this invention is explained with reference to a drawing.

[0021] Drawing 1 is the sectional view showing the configuration of the 1st example of the piezoelectric-device electrode structure concerning this invention.

[0022] Setting to drawing 1 , for a piezo-electric ceramic component (piezoelectric device) and 3, a conductive layer and 4 are [1 / a conductive electrode and 2] a stress relaxation layer and 41. A minerals porous body and 42 As for a conductive particle and 5, a glue line and 6 are component attaching parts.

[0023] and the thing which the conductive electrode 1 becomes from the conductive layer 3 by which

adhesion arrangement was carried out on both sides of the piezo-electric ceramic component 2, respectively, and the stress relaxation layer 4 by which adhesion arrangement was carried out on each conductive layer 3 -- it is -- the stress relaxation layer 4 -- minerals porous body 41 Conductive particle 42 from -- it has become. It sets in this stress relaxation layer 4, and is the conductive particle 42. Minerals porous body 41 While restoration arrangement is carried out at each porous circles, it will be distributed on each outskirts of the porous section. Each stress relaxation layer 4 is pasted up on the component attaching part 6 through a glue line 5, and the piezo-electric ceramic component 2 which carried out adhesion arrangement of the conductive electrode 1 to both sides by it is held by the component attaching part 6.

[0024] In this case, the stress relaxation layer 4 is the minerals porous body 41 to be used. Conductive particle 42 Although it changes a little with physical characteristics, it is desirable to form in general, so that that thickness may be set to 100 micrometers or less. This reason is that the residual stress based on the difference in the coefficient of thermal expansion of the piezo-electric ceramic component 2 and the stress relaxation layer 4 may become large, and the piezo-electric ceramic component 2 and the stress relaxation layer 4 may exfoliate when the thickness of the stress relaxation layer 4 exceeds 100 micrometers.

[0025] Moreover, conductive particle 42 used for the stress relaxation layer 4 It is suitable if mean particle diameter uses a particle 5 micrometers or less. namely, conductive particle 42 ****** -- the case where the particle whose mean particle diameter is a particle 5 micrometers or less and whose mean particle diameter is about 1 micrometer is used -- minerals porous body 41 The particle in the condition of having surrounded the particle and the porous section in the condition that porous circles were filled up presents a good lubrication action within the stress relaxation layer 4, and reduces the residual stress which joins the piezo-electric ceramic component 2 on an effective target. on the other hand -- conductive particle 42 ****** -- when mean particle diameter uses a particle 5 micrometers or more, the piezo-electric ceramic component 2 may be damaged at last with the big residual stress which the lubrication action of those particles in the stress relaxation layer 4 becomes so good less, and reduction of the residual stress which joins the piezo-electric ceramic component 2 is no longer given to an effective target, and joins the piezo-electric ceramic component 2

[0026] Thus, while joining a conductive layer 3 on the piezo-electric ceramic component 2 according to the piezoelectric-device electrode structure of the 1st example The stress relaxation layer 4 is joined on that conductive layer 3, and it is the minerals porous body 41 about this stress relaxation layer 4. Conductive particle 42 Since it is made the intermingled configuration The big residual stress generated based on the difference in the coefficient of thermal expansion of the piezo-electric ceramic component 2 and the conductive electrode 1 Minerals porous body 41 of the stress relaxation layer 4 Deformation and/or the minerals porous body 41 of the very thing Intermingled conductive particle 42 It is fully eased by slipping actuation etc. For example, even if it uses the piezo-electric ceramic component 2 under the environment of a high temperature condition, it can prevent beforehand that the piezo-electric ceramic component 2 is damaged.

[0027] Next, drawing 2 (a) and (b) are the block diagrams showing the configuration of the 2nd example of the piezoelectric-device electrode structure concerning this invention, it is the perspective view, (b) is some of the enlarged section block diagrams, and (a) shows the example which constituted the piezoelectric device in the laminating mold piezoelectric device.

[0028] As for a conductive electrode and 8, in drawing 2 (a) and (b), a layer indirect arrival layer and 9 have attached [7 / an insulator and 10] the same sign about the same component as the component with which a band-like external electrode and 11 are leads, in addition were shown in drawing 1 .

[0029] And the conductive electrode 7 consists of the conductive layer 3 by which formation arrangement is carried out between two piezo-electric ceramic components 2 by which the laminating was carried out, and adhesion arrangement was carried out, respectively on each opposed face of the piezo-electric ceramic component [on the other hand / (above)] 2 and the piezo-electric ceramic component 2 of another side (below), a stress relaxation layer 4 by which adhesion arrangement was carried out on each conductive layer 3, respectively, and a layer indirect arrival layer 9 which pastes up

each stress relaxation layer 4. each stress relaxation layer 4 -- minerals porous body 41 Conductive particle 42 from -- becoming -- conductive particle 42 Minerals porous body 41 While restoration arrangement is carried out at each porous circles, it will be distributed on each outskirts of the porous section.

[0030] Moreover, the side face of another side is formed in the condition of having equipped with the insulator 9 at the condition [in / the odd-numbered conductive electrode 7] that the side face was exposed, respectively, and each conductive electrode 7 is formed in the condition that the side face of another side was exposed to the condition that the side face equipped with the insulator 9 in the even-numbered conductive electrode 7 reversely, respectively. In one side face of each conductive electrode 7, and the side face of another side, along the direction of a laminating of the piezo-electric ceramic component 1, wearing arrangement is carried out, each conductive electrode 7 is connected conductively to each band-like external electrode 10 in the exposed part, and the band-like external electrode 10 is insulated with each band-like external electrode 10 in the part equipped with an insulator 9, respectively. In addition, the lead 11 is connected to the edge of each band-like external electrode 10.

[0031] It is the minerals porous body 41 which uses the stress relaxation layer 4 like the 1st example also in the 2nd example. Conductive particle 42 Although it changes a little with physical characteristics, it is desirable to form so that an outline and its thickness may be set to 100 micrometers or less. The reason is that the residual stress based on the difference in the coefficient of thermal expansion of the piezo-electric ceramic component 2 and the stress relaxation layer 4 may become large, and the piezo-electric ceramic component 2 and the stress relaxation layer 4 may exfoliate when the thickness of the stress relaxation layer 4 exceeds 100 micrometers.

[0032] Moreover, conductive particle 42 used for the stress relaxation layer 4 like the 1st example also in the 2nd example It is suitable if mean particle diameter uses a particle 5 micrometers or less. namely, conductive particle 42 ****** -- the case where the particle whose mean particle diameter is a particle 5 micrometers or less and whose mean particle diameter is about 1 micrometer is used -- minerals porous body 41 Particle 42 in the condition that porous circles were filled up Particle 42 in the condition of having surrounded the porous section A good lubrication action is presented within the stress relaxation layer 4, and the residual stress which joins the piezo-electric ceramic component 2 is reduced on an effective target. on the other hand -- conductive particle 42 ****** -- when mean particle diameter uses a particle 5 micrometers or more, the piezo-electric ceramic component 2 may be damaged at last with the big residual stress which the lubrication action of those particles in the stress relaxation layer 4 becomes so good less, and reduction of the residual stress which joins the piezo-electric ceramic component 2 is no longer given to an effective target, and joins the piezo-electric ceramic component 2

[0033] Thus, while according to the piezoelectric-device electrode structure of the 2nd example joining the stress relaxation layer 4 to the plane-of-composition side of the piezo-electric ceramic component 2 by which a laminating is carried out through a conductive layer 3, respectively and really joining these stress relaxation layers 4 It is the minerals porous body 41 about the stress relaxation layer 4. Conductive particle 42 Since it is made the intermingled configuration The big residual stress generated based on the difference in the coefficient of thermal expansion of the piezo-electric ceramic component 2 and the conductive electrode 7 Minerals porous body 41 of the stress relaxation layer 4 Deformation and/or the minerals porous body 41 of the very thing Intermingled conductive particle 42 It fully comes to be eased by slipping actuation etc. For example, even if it uses this laminating mold piezo-electricity ceramic component 2 under the environment of a high temperature condition, it can prevent beforehand that each piezo-electric ceramic component 2 is damaged.

[0034] Here, it is as follows when the manufacture approach of the piezoelectric-device electrode structure of the 1st example and the 2nd example is described.

[0035] Introduction and the piezoelectric-device electrode structure of the 1st example 1 are manufactured as follows.

[0036] First, 5mm of predetermined dimensions which use titanic-acid zirconate (PZT) as a principal component, for example, length, 5mm wide, and the piezo-electric ceramic plate 1 with a thickness of 0.5mm are prepared.

[0037] Next, the sol solution which contained the silver (Ag) particle and the palladium (Pa) particle 20% is applied to both sides of this piezo-electric ceramic plate 1.
[0038] Subsequently, the sol solution which contained the sol solution and silver (Ag) particle which contained silicon oxide (SiO2) 20%, and the palladium (Pa) particle 20% is applied by turns on the field which applied said sol solution.
[0039] Then, each sol solution applied to the piezo-electric ceramic plate 1 is heated for 30 minutes at the temperature of 200 degrees C, and the conductive electrode 1 which consists of a conductive layer 3 and a stress relaxation layer 4 is formed.
[0040] Subsequently, the piezo-electric ceramic plate 1 in which the conductive electrode 1 was formed to both sides is pasted up on the component attaching part 6 using the inorganic elevated-temperature binder which uses nickel (nickel) and a zirconia as a principal component, and the piezo-electric ceramic component 1 in which the conductive electrode 1 was formed is made to hold to the component attaching part 6 by the glue line 5.
[0041] Thus, it can manufacture the piezoelectric-device electrode structure which can ease the big residual stress which joins a piezoelectric device with a cheap manufacturing cost while a comparatively easy manufacture means can be used for it, since the manufactured piezoelectric-device electrode structure can form a stress-relaxation layer by carrying out stoving of the field which applied the sol solution containing the sol solution and the silicon oxide containing a conductive particle to the front face of a piezo-electric plate, and applied these sol solutions to it.
[0042] Next, the piezoelectric-device electrode structure of the 2nd example is manufactured as follows.
[0043] First, only the number by which a laminating is carried out prepares 5mm of predetermined dimensions which use titanic-acid zirconate (PZT) as a principal component, for example, length, 5mm wide, and the piezo-electric ceramic plate 1 with a thickness of 0.5mm.
[0044] Next, the sol solution which contained the silver (Ag) particle and the palladium (Pa) particle 20% is applied to the whole surface of two piezo-electric ceramic plates 1 in these piezo-electric ceramic plates 1, and both sides of the piezo-electric remaining ceramic plate 1, respectively.
[0045] Subsequently, the sol solution which contained the sol solution and silver (Ag) particle which contained silicon oxide (SiO2) 20%, and the palladium (Pa) particle 20% is applied by turns on each field which applied said sol solution.
[0046] Then, each sol solution applied to each piezo-electric ceramic plate 1 is heated for 30 minutes at the temperature of 200 degrees C, and a conductive layer 3 and the stress relaxation layer 4 are formed.
[0047] Next, the thing comrade as for whom the stress relaxation layer 4 formed in each piezo-electric ceramic plate 1 does a laminating is made to counter, respectively, two stress relaxation layers 4 made to counter using the inorganic elevated-temperature binder which uses nickel (nickel) and a zirconia as a principal component, respectively are pasted up, and the conductive electrode 7 is formed. At this time, the laminating mold piezoelectric device by which wearing arrangement of the conductive electrode 7 was carried out, respectively between each piezo-electric ceramic plate 1 by which laminating arrangement is carried out has been obtained.
[0048] Subsequently, on the other hand, the conductive electrode 7 of a laminating mold piezoelectric device reaches, and the side face of another side is alternately equipped with the insulator 9 of a cross-section boiled-fish-paste form, respectively.
[0049] Then, on the other hand, the conductive electrode 7 of a laminating mold piezoelectric device reaches, junction wearing of the band-like external electrode 10 is carried out, respectively, and weldbonding of the lead 11 is carried out to the side face of another side at the edge of each band-like external electrode 10.
[0050] Thus, the manufactured piezoelectric-device electrode structure Like the manufacture approach of the piezoelectric-device electrode structure of the 1st example, on the front face of two or more piezo-electric plates Since a stress relaxation layer can be formed by carrying out stoving of the field which applied the sol solution containing the sol solution and silicon oxide containing a conductive particle, respectively, and applied these sols solution, respectively While being able to use a comparatively easy manufacture means, the piezoelectric-device electrode structure which can ease the big residual stress

which joins a piezoelectric device with a cheap manufacturing cost can be manufactured.
[0051] In addition, a conductive particle usable to the manufacture approach of this invention is not restricted to a silver (Ag) particle and a palladium (Pa) particle, and as long as it is metal particles which have good conductivity, you may make it use other particles in the manufacture approach of the piezoelectric-device electrode structure of the 1st and 2nd examples, although the example using the silver (Ag) particle and the palladium (Pa) particle as a conductive particle was given and explained.
[0052] Moreover, although the example using the inorganic elevated-temperature binder which uses nickel (nickel) and a zirconia as a principal component was given and explained in the manufacture approach of the piezoelectric-device electrode structure of the 1st and 2nd examples when forming a glue line If adhesives usable to the manufacture approach of this invention are adhesives which are not restricted to the inorganic elevated-temperature binder which uses nickel (nickel) and a zirconia as a principal component, and have a similar property in this inorganic elevated-temperature binder, they are good as for other methods for adhesives of ****.
[0053] It examined by incidentally using for the fuel supply system of a gasoline engine the laminating mold piezoelectric device which has the piezoelectric-device electrode structure of the 2nd example at a nest and the actuator for gasoline injections. Under an environment with a temperature of 120 degrees C, this trial was able to change the engine speed to 500 thru/or 10000rpm, and is able to investigate the injection condition of a gasoline, and that result was able to reduce the gasoline injection speed of response to an input signal or less to 1/5 in all engine speeds compared with the case where the conventional electromagnetic actuator is used.
[0054]
[Effect of the Invention] As mentioned above, while according to the piezoelectric-device electrode structure of this invention joining a direct conductive layer on a piezoelectric device and joining a stress relaxation layer on this conductive layer, respectively Since each stress relaxation layer is made the configuration intermingled in the conductive matter at the minerals porous body Even if big residual stress occurs between a piezoelectric device and a conductive electrode based on the difference in the coefficient of thermal expansion of a piezoelectric device and a conductive electrode, the big residual stress The minerals porous body of a stress relaxation layer itself deforms, or or the conductive matter intermingled in a minerals porous body performs slipping actuation, or Or it is effective in the piezoelectric-device electrode structure which it is fully eased, consequently can prevent breakage of a piezoelectric device being acquired by using together deformation of the minerals porous body itself and slipping actuation of the conductive matter.
[0055] In this case, it is effective in the relaxation function to big residual stress increasing by constituting the conductive matter which makes a minerals porous body intermingled from a conductive particle, and as a conductive particle, if mean particle diameter uses a thing 5 micrometers or less, it is effective in becoming possible to increase the relaxation function to big residual stress more.
[0056] Moreover, it is effective in the ability to be able to manufacture the piezoelectric-device electrode structure which can ease the big residual stress which can use a comparatively easy manufacture means since according to the manufacture approach of the piezoelectric-device electrode structure of this invention apply the sol solution containing the sol solution and the silicon oxide containing a conductive particle to the front face of a piezo-electric plate, it is made to carry out stoving of the spreading field of these sol solutions and the stress-relaxation layer is formed in it, and also joins a piezoelectric device with a cheap manufacturing cost.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] It is the piezoelectric-device electrode structure characterized by consisting of a conductive layer by which said conductive electrode is joined by both sides of a piezoelectric device on said piezoelectric device in the piezoelectric-device electrode structure which carried out junction arrangement of the conductive electrode, and a stress relaxation layer of the structure which was joined on said conductive layer and intermingled in the conductive matter in the minerals porous body.
[Claim 2] In the piezoelectric-device electrode structure which carried out junction arrangement of the conductive electrode in the plane of composition of the 1st and 2nd piezoelectric devices by which the laminating was carried out at least to two-layer said conductive electrode The conductive layer by which junction arrangement is carried out on said 1st and 2nd piezoelectric devices, respectively, and the stress relaxation layer of the structure which junction arrangement was carried out on said each conductive layer, respectively, and was intermingled in the conductive matter in the minerals porous body, Piezoelectric-device electrode structure characterized by consisting of a junctional zone between layers which really joins the stress relaxation layer by the side of said 1st piezoelectric device, and the stress relaxation layer by the side of said 2nd piezoelectric device.
[Claim 3] The conductive matter intermingled in said minerals porous body is piezoelectric-device electrode structure according to claim 1 or 2 characterized by including a conductive particle.
[Claim 4] Said conductive particle is piezoelectric-device electrode structure according to claim 3 characterized by being what mean particle diameter becomes from a particle 5 micrometers or less.
[Claim 5] The process which applies the sol solution of the piezo-electric plate which constitutes a piezoelectric device which contains a conductive particle on the whole surface at least, and forms the electric conduction spreading film, The process which applies the sol solution containing the sol solution and silicon oxide containing a conductive particle, forms the 2nd spreading film, carries out stoving of the 2nd spreading film with said electric conduction spreading film, and forms a conductive layer and a stress relaxation layer on said electric conduction spreading film, The manufacture approach of the piezoelectric-device electrode structure characterized by manufacturing a ****** conductivity electrode.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the configuration of the 1st example of the piezoelectric-device electrode structure concerning this invention.
[Drawing 2] They are the perspective view showing the configuration of the 2nd example of the piezoelectric-device electrode structure concerning this invention, and some expanded sectional views.
[Description of Notations]
1 Seven Conductive electrode
2 Piezo-electric Ceramic Component (Piezoelectric Device)
3 Conductive Layer
4 Stress Relaxation Layer
41 Minerals Porous Body
42 Conductive Particle
5 Glue Line
6 Component Attaching Part
8 Layer Indirect Arrival Layer
9 Insulator
10 Band-like External Electrode
11 Lead

[Translation done.]